DUAL FUNCTION TRANSDUCER

FIELD

[0001] An aspect of the invention is directed to a dual function transducer, more specifically, a dual function transducer that contains a single magnet motor assembly for loudspeaker and shaker functionality. Other aspects are also described and claimed.

BACKGROUND

[0002] In modern consumer electronics, audio capability is playing an increasingly larger role as improvements in digital audio signal processing and audio content delivery continue to happen. In this aspect, there is a wide range of consumer electronics devices that can benefit from improved audio performance. For instance, smart phones include, for example, electro-acoustic transducers such as speakers that can benefit from improved audio performance. Smart phones, however, do not have sufficient space to house multiple transducers and/or actuators typically used to achieve various functions that may be desirable (e.g., acoustic output, haptic output, etc.). This is also true for some portable personal computers such as laptop, notebook, and tablet computers, and, to a lesser extent, desktop personal computers with built-in transducers.

SUMMARY

[0003] An aspect of the disclosure is directed to a dual function transducer that can be used as both an electroacoustic transducer (e.g., loudspeaker) and a tactile transducer (e.g., shaker). The loudspeaker functionality may be used to output sound from the device while the shaker may be used to produce a haptic output, for example by vibrating a surface it is connected to. The transducer may include a single magnet motor assembly that accommodates both the loudspeaker components (e.g., piston and voice coil) and shaker components (e.g., shaker coil) so that both functions can be achieved using a single transducer. Representatively, the single magnet motor assembly may be used to generate one or more magnetic field(s) that are used by subcomponents of the dual function transducer to generate the desired output. For example, one of the subcomponents may provide the shaking (e.g., vibration) function and another of the subcomponent may serve a loudspeaker function. Both functions may require the electromechanical actuation of a portion of the components. The actuation may be in a same platen for both functions in the dual function transducer. The magnetic system design may therefore enable the utilisation of two functions by directing the magnetic field into two or more sets of high magnetic field density. One or more sets will be utilized by the vibration function, and the other set by the loudspeaker function.

[0004] Representatively, in one aspect, the vibration function may use a static coil that is placed in one of the sets of high magnetic field density so that it can generate an electromagnetic force when an electrical current is applied to the coil. The magnetic system may be assembled to a compliant suspension system. When the force is generated by the coil, the magnetic system may move (actuate) to transmit a physical motion/force outside the system. The loudspeaker function may have a coil that is attached to a lightweight piston (e.g., diaphragm) that is connected to a suspension system. This is assembled such that the coil is suspended in the other set of high magnetic field density area from the magnetic system. In the loudspeaker application, the magnetic system has essentially no movement but the electromagnetic force generated moves the coil/piston assembly. This provides the mechanism to generate audible frequencies, for example, from 100 Hz to 20 kHz. The vibration function may require relatively low frequencies which are generally inaudible, whereas the loudspeaker function uses a portion of the audible frequency band. The different coils for the vibration and loudspeaker functions may have the ability to be driven independently by different channels on an amplifier, or together by the same channel, depending on the application needs. The dual function transducer provides the additional advantage of enabling sufficient space (volume) savings in the system, and can be made much more compact two separate modules used to achieve vibration and loudspeaker functions.

[0005] More specifically, aspects of the disclosure include a transducer assembly having a magnet motor assembly, and a piston and voice coil coupled to the magnet motor assembly. The magnet motor assembly may include a first magnet plate and a second magnet plate arranged along an axis, a first support plate positioned between inward facing surfaces of the first magnet plate and the second magnet plate, a second support plate positioned along an outward facing surface of the first magnet plate to form a first magnetic gap between the first support plate and the second support plate and a third support plate positioned along an outward facing surface of the second magnet plate to form a second magnetic gap between the first support plate and the third support plate. The voice coil may be positioned around the first support plate and within the magnetic gap, and the piston vibrates in a direction parallel to the axis. In some aspects, the first support plate and the second support plate extend beyond ends of the first magnet plate and the second magnet plate such that the magnetic gap is formed by surfaces of the first support plate and the second support plate and the ends of the first magnet plate and the second magnet plate. The inward facing surfaces of the first magnet plate and the second magnet plate may have a same magnetic pole, and a magnetic flux line across the magnetic gap may be perpendicular to a winding height of the voice coil. In some aspects, a length or a width of the first magnet plate and the second magnet plate may be parallel to the axis. The magnet motor assembly may be a first magnet motor assembly, the piston is a first piston and the voice coil is a first voice coil, and the assembly may further include a second magnet motor assembly that shares a third support plate positioned along an outward facing surface of the second magnet plate with the first magnet motor assembly. The second magnet motor assembly may include a third magnet plate, a fourth magnet plate and a fourth support plate, the third magnet plate is positioned between the third support plate and the fourth support plate, and the fourth magnet plate is positioned along a side of the fourth support plate opposite the third magnet plate; and a second piston and a second voice coil arranged along an end of the third magnet plate and the fourth magnet plate. In some aspects, the axis is a first axis, and the second piston vibrates along a second axis that is at an angle to the first axis. The piston and the voice coil may include a first piston and a first voice coil, and the transducer assembly may further include a second piston and a second